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ANNALS OF PHYSICAL MEDICINE

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ORIGINAL PAPER

THE GRAPHIC REPRESENTATION OF MOVEMENT*
I. ELECTROMYOGRAPHY OF POSTURAL MUSCLES

By J. JOSEPH

From the Department of Anatomy, Guy's Hospital Medical School, London

THIS paper briefly reports an electromyographic study of the stand-at-ease position. The subjects stood with their feet comfortably apart, toes turned out about 30 degrees, hands clasped lightly behind the back, and the head held with the eyes looking forwards. This is a posture which is readily reproduced and is similar in all subjects; it is also one which is frequently referred to in textbooks and in studies on the centre of gravity of the body, the line of weight, etc.

The electromyograph had a low noise level (2 μV) and a very high amplification, and was in a screening cage. These features were required because small potentials from contracting muscles might be missed and interference from outside sources had to be eliminated. Surface electrodes, retained in position by suction, were used.

The muscles were also studied while they were relaxed. No evidence of motor activity was found, and it was concluded that the common concept of muscle tone should be abandoned. This is in agreement with the findings of many workers. It should be pointed out that when the electrodes were placed anywhere on the body there was detected a slight increase in electrical activity to about 5–7 μV. This is called "tissue noise".

* The three papers under this heading are based on a symposium presented at the Annual Meeting of the British Association of Physical Medicine, April 29, 1959.

In the position described, in the great majority of men and women, continuous and somewhat variable activity was found in the calf muscles, and no activity in the tibialis anterior, quadriceps femoris, and hamstring muscles. In men, no activity was found in the iliopsoas, gluteus medius and minimus, and gluteus maximus muscles. These hip muscles were not studied in women.

It was concluded that in most subjects only the calf muscles were continuously active in the stand-at-ease position. Consideration of the relation of the line of weight (the perpendicular through the centre of gravity) to the ankle-, knee-, and hip-joints supports these results. This line falls in front of the transverse axis of the ankle-joints and knee-joints and behind those of the hip-joints. Falling forwards at the ankle-joints is prevented by the calf muscles, and at the knee-joints by the appropriate ligaments. Falling backwards at the hip-joints is prevented by ligaments.

Normally the ordinary swaying of the body did not alter the relation of the line of weight to these joints, but deliberate forward swaying at the ankles resulted in activity in the hamstrings, which contracted and prevented excessive extension at the knee-joints and/or flexion at the hip-joints. Backward swaying resulted in activity in the tibialis anterior and quadriceps femoris. Raising the arms forwards at the shoulders to about 15 degrees of flexion also had the effect of producing activity in the hamstrings due to a shift forwards of the line of weight.

These investigations have made it necessary to reconsider the role of muscles and ligaments in maintaining the upright posture and also the common concept of muscle tone.

ORIGINAL PAPER

THE GRAPHIC REPRESENTATION OF MOVEMENT

II. RELATIONSHIP BETWEEN MUSCLE FORCE AND THE ELECTROMYOGRAM IN THE STAND-AT-EASE POSITION

By A. NIGHTINGALE

From the Physics Department, Guy's Hospital Medical School, London

ELECTROMYOGRAPHY is frequently employed to discover the role of a given muscle in a particular position or movement. Implicit in such investigations is the assumption that there is a simple relationship between the electromyogram and the tension developed by the muscle. It is correct to assume that, in general, the amplitude (A) gets bigger as the force (F) increases, but it is not possible to generalize about the precise form of the relationship. I have deduced the following equations from previous publications. The symbol K represents constants.

$A=K_1+K_2F$. Forearm flexor muscles, wrist flexion. (Travis and Lindsley, 1931.)

$A=K_3F_2$. Triceps brachii. (Inman, Saunders, and Abbott, 1944.)

Log A $\propto$ log F or very approximately $A=K_4F^{0.8}$. Extensor and flexor muscles of wrist. (Dempster and Finerty, 1947.)

$A=K_5+K_6F$. Calf muscles, plantar flexion at ankle-joint. (Lippold, 1952.)

$A=K_7F$. Various muscles. For biceps K_7 was of the order of 1 μV r.m.s./kg. wt. At high tensions the curve relating A to F became convex to the tension axis. (Snyder, 1953.)

$A=K_8F$. Short head of biceps brachialis. K_8 was about 4 μV r.m.s./kg. wt. (Hines, Keever, and Bennett, 1956.)

These results are not strictly comparable, since the frequency ranges covered by the amplifiers and the types of electrode used were different, and I have had to make certain assumptions about the mechanical advantage of the lever system in the last two cases. Furthermore, Snyder (1953) and Hines *et al.* (1956) were the only authors who investigated very low levels of activity and who expressed their results in absolute units.

The present work arose from investigations of posture (Joseph and Nightingale, 1952, 1956; Joseph, Nightingale, and Williams, 1955) during which it was found that the soleus muscle was continuously active in most subjects. This fitted in with the well-known fact that the line of weight falls, on the

average, about 6 cm. in front of the ankle-joint, so that the calf muscles must be continuously active to prevent falling forwards at the ankle. It therefore seemed desirable to make a detailed analysis of one subject, in which simultaneous observations were made of the line of weight and of the electromyogram, the position adopted being as close as possible to the stand-at-ease position already investigated.

METHOD

The amplifier (Nightingale, 1958) was designed to have a low noise level—about 2 μV peak to peak. Its frequency response was constant between 20 and 1,000 cycles per second. This is the band required for accurate recording and measurement of the electromyogram when surface electrodes are used (Nightingale, 1959). The electrodes were silver suction disks 1 cm. in diameter. The skin was prepared by cleansing with soap and water, shaving, rubbing gently with fine sandpaper, and finally rubbing with Cambridge electrode jelly. The electrodes were placed 5 cm. apart over the soleus muscle, one-third of the way down from the tibial tuberosity towards the distal end of the lateral malleolus, and 1 cm. behind the postero-medial border of the tibia. The placing of electrodes about 5 cm. apart over the belly of the muscle was shown by Snyder (1953) to give the most consistent and reproducible results. The subject and amplifier were enclosed in an expanded metal screening cage. The output from the amplifier was connected to a cathode-ray oscilloscope and was also measured by means of a valve voltmeter, which was calibrated by comparison with a thermocouple meter to give the root mean square value. Supplementary experiments showed that the peak-to-peak value, as read from photographic records for the "interference pattern" waveform, could be obtained approximately by multiplying the r.m.s. value by about four or five.

The subject, wearing normal clothing, was placed with a foot on each of two boards. Each board was supported at one end on a knife-edge and at the other on the platform of a weighing machine. The subject stood comfortably with the head erect, the feet about 50 cm. apart, and the hands lightly clasped behind the back. Knowing the weight of the subject, the position of the line of weight could be deduced from the readings of the weighing machine. The most distal point of the lateral malleolus was used as a reference mark on the subject, since this is close to the axis of the ankle-joint. In order to vary the tension in the calf muscles the subject was asked to lean a little farther forward or backward from his comfortable stand-at-ease position. Each position was held for some 30 seconds, and the mean value of the amplitude of the electromyogram during this period was recorded.

RESULTS AND DISCUSSION

Fig. 1 shows the results for two separate experiments on the same subject. The figures for the amplitude of the electromyogram in the two experiments agreed reasonably well except for the case where the line of weight was directly over the mark on the ankle. This was a position of unstable equilibrium which the subject found great difficulty in maintaining, and irregular bursts of electrical activity were produced by his muscle. The amplitude in this position was much greater than the value of 2 μV r.m.s. (10 μV peak to peak) which was obtained when he was resting comfortably on a bed and which represents the true "base-line" in electromyographic investigations (Nightingale, 1959). Thus, although a

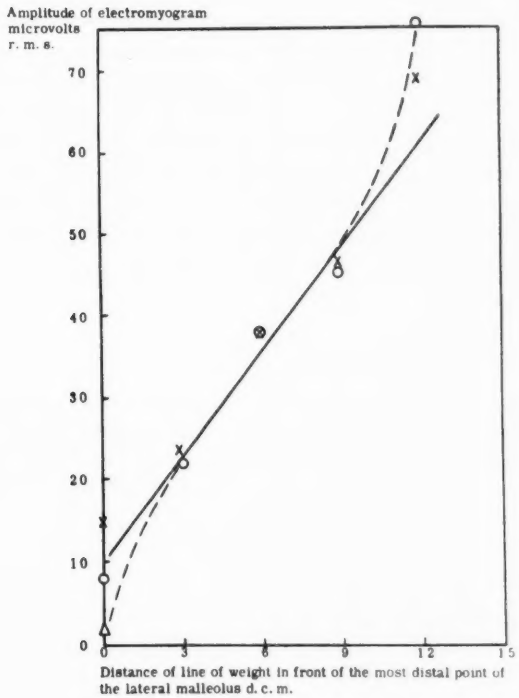


FIG. 1.—The relation between the amplitude of the electromyogram and the distance of the line of weight in front of the ankle-joint for a subject in the stand-at-ease position. The circles and crosses represent two separate sets of observations made on different days. The triangle gives the amplitude of the electromyogram when the subject was at rest, lying comfortably on a bed. The figures given on the horizontal axis can be converted approximately to the tension in kg. wt. by multiplying by 14.

straight line could be drawn through the first four pairs of points, it was thought preferable to discount the first pair, and to draw a tentative curve at the lower end as shown in Fig. 1. The upward curvature at the higher values was similar to that reported by Snyder (1953), and may have been associated with the onset of fatigue, since it corresponded to a position in which the subject's line of weight fell through the ball of the foot. Edwards and Lippold (1956) showed that the amplitude of the electromyogram increases very markedly with fatigue. The central roughly straight portion may perhaps correspond to the

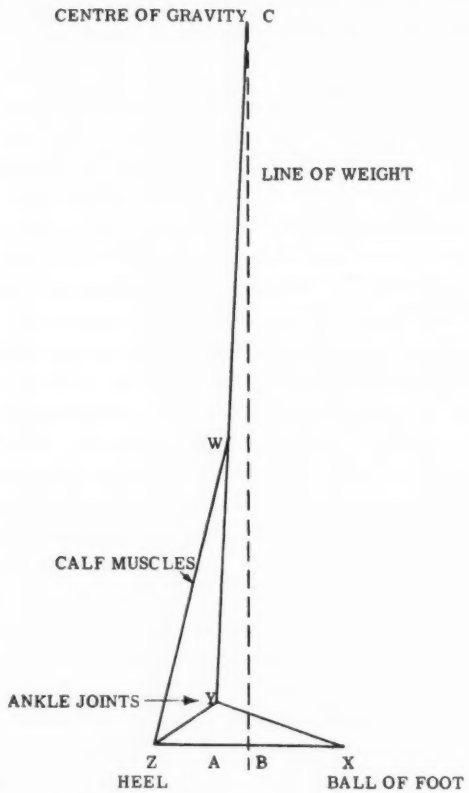


FIG. 2.—A simplified mechanical diagram representing a subject in the stand-at-ease position, to show the average position of the line of weight. The following data were used to calculate the force in the calf muscles:

Height 180 cm., weight 78·4 kg.
AC=55% of height=99 cm.
YC=94 cm.; AY=5 cm.; AX=16 cm.; AZ=3·2 cm.; YW=33 cm.

straight-line relationships obtained by Lippold (1952), who did not extend his measurements to very low tensions.

The absolute tension in the calf muscles was calculated using a simple mechanical model (Fig. 2). A number of simplifying assumptions were made. The calf muscles were lumped together into a single tie between the heel and a point near the knee level. The legs and body were treated as a single rigid structure and the ankle as a simple hinge. It was found that the figures for the distance of the line of weight in front of the lateral malleolus could be converted to the approximate tension in kilogrammes weight by multiplying by a factor of 14. Over the central straight portion of the curve the amplitude of the electromyogram increased at the rate of 0·3 μV (r.m.s.) per kg. wt. The value obtained by Snyder (1953) for the biceps was about 1 μV per kg. wt. In his most comfortable stand-at-ease position the line of weight for this subject fell about 6 cm. in front of his ankle-joint, the calculated tension in his calf muscles was 80 kg. wt., and the corresponding amplitude of the electromyogram was 35 μV r.m.s. (about 150 μV peak to peak).

It is clear that the simplifying assumptions outlined above are rather drastic, and that in particular the gastrocnemius muscle may play a separate role from that of the soleus. Experiments are planned in which a two-channel equipment will be used to obtain simultaneously the electromyograms of both muscles, and in which the studies will be extended to a number of different subjects.

Acknowledgments

I should like to thank Dr. J. Joseph and Mr. C. K. Battye for many valuable discussions; Mr. K. Twinn and Mr. F. Huthwaite for their help in the experimental work; and the Department of Medical Illustration, Guy's Hospital Medical School, for preparing the figures.

References

Dempster, W. T., and Finerty, J. C. (1947) *Amer. J. Physiol.*, **150,** 596.
Edwards, R. C., and Lippold, O. C. J. (1956) *J. Physiol.*, **132,** 677.
Hines, T. F., Keever, K. W., and Bennett, R. L. (1956) *J. appl. Physiol.*, **9,** 473.
Inman, V. T., Saunders, J. B. de C., and Abbott, L. C. (1944) *J. Bone Jt Surg.*, **42,** 1.
Joseph, J., and Nightingale, A. (1952) *J. Physiol.*, **117,** 484.
——— ——— (1956) Ibid., **132,** 465.
——— ——— and Williams, P. L. (1955) Ibid., **127,** 617.
Lippold, O. C. J. (1952) Ibid., **117,** 492.
Nightingale, A. (1958) *J. sci. Instrum.*, **35,** 366.
——— (1959) *Phys. in Med. Biol.*, **3,** 325.
Snyder, R. A. (1953) Ph.D. Thesis, University of Western Ontario, London, Ontario, Canada.
Travis, L. E., and Lindsley, D. B. (1931) *J. exp. Psychol.*, **14,** 359.

ORIGINAL PAPER

THE GRAPHIC REPRESENTATION OF MOVEMENT
III. SEQUENCE STILL PHOTOGRAPHS FOR THE ANALYSIS OF MOVEMENT

By C. E. ENGEL

From Guy's Hospital Medical School, London

WHENEVER the study of movement is part of a research problem the motion-picture film tends to be considered as a possible solution. It is true that the projected film will portray motion with considerable accuracy. However, movement is a complex event which is so transient that the eye and mind cannot evaluate it as it passes across the screen. The film can therefore yield no more than a subjective impression.

Objective analysis requires the study of individual still pictures, separately and in relation to each other. Tracings, superimposition, and reduction to more or less simple curves from these individual images are used to evaluate movement. Although individual frames from a motion-picture film can be studied in this way, the process is cumbersome and wasteful of both time and material. The average film camera will record at 16 frames per second (f.p.s.) with exposure times of 1/30 second. Even at 32 f.p.s. with 1/60-second exposures motion is not arrested sufficiently to yield images which are sharp enough for accurate delineation.

As long ago as the end of last century Muybridge in the United States used a series of still cameras to record animals and human beings in motion. To-day, cameras such as the German Robot, the American Hultcher, and the British Shackman are available for this purpose. The Shackman camera accommodates sufficient film for 200 separate pictures; these can be exposed at speeds up to 1/200 second and at any interval from four per second to one per hour through an electric interval-timing device. Automatic counters, frame markers, and time signals are also available. The most recent model extends the range of film which can be used from a width of 35 mm. to one of 70 mm.

The application of this particular equipment is obviously limited to the recording of movement which can be arrested in up to 1/200 second, and where individual components of the phenomenon can be studied adequately in as few pictures as four per second. It is possible to utilize continuously moving film and to let light bulbs, attached to the body, effect tracings which can be measured and compared. However, this has the disadvantage that interpretation by reference to the body as a whole is not possible.

The continuous strip of individual photographs of the subject in motion can be evaluated very readily if certain elementary precautions for standardization have been observed. A piece of translucent tracing-paper is superimposed on the first picture. A static reference line is traced through, as well as the point or points in the picture which constitute the limb which is to be observed. The graph paper is then made to lie over the second image, so that the tracing of the first reference line is superimposed on the photographic reference line of the second image. The same anatomical landmarks are now traced through in their new positions. When all the images have been traced in this manner the related points can be connected to form curves. These will show movement in two dimensions against time, as the time interval between tracings will be known from the rate of recording of the photographic strip. Simplicity of recording and construction of curves is matched by the ease of individual interpretation and comparison with curves obtained from the same patient at different times or with those of other patients.

ORIGINAL PAPER

RESULTS OF REHABILITATION AND RESETTLEMENT IN RHEUMATOID ARTHRITIS*

BY RONALD HARRIS

From the Devonshire Royal Hospital, Buxton

THE Devonshire Royal Hospital, Buxton, has been developed by the Manchester Regional Hospital Board as its main centre for the treatment of rheumatic diseases and of major rehabilitation. As the hospital has this joint function, much of the work of the rehabilitation unit has been the care and treatment of patients with rheumatic diseases. About 50% of the patients admitted to the rehabilitation unit have rheumatoid arthritis. In the five-year period 1953–8, out of a total of 1,928 patients admitted, there were 988 with rheumatoid arthritis (R.A.). In this paper are analysed the results obtained with this group of patients.

MATERIAL

The 988 patients studied were in-patients in the rehabilitation unit. Over half of them had been transferred to the unit from one of the medical rheumatism services (Dr. Barber, Professor Kellgren), either within the Devonshire Royal Hospital or from beds or out-patient clinics in other hospitals (Manchester Royal Infirmary, Withington Hospital) served by these units.

In general, patients with early, active R.A. are not admitted to the rehabilitation unit. They are treated by the rheumatism units, and the majority do not become seriously disabled. The primary purpose of the rehabilitation unit is to handle the patient who has become a serious re-ablement and resettlement problem, and our figures show that the majority of the patients admitted were substantially disabled. The patients with R.A. admitted have quiescent or chronic disease, and virtually all have permanent joint damage. Many have been completely helpless for years. There is a free movement of patients between the various units in the Devonshire Royal Hospital, but the main flow is naturally to the rehabilitation unit. If the disease becomes reactivated the patient is usually returned to the rheumatism service until again fit for rehabilitation. Many patients are transferred to the rehabilitation unit with their disease stabilized on steroid therapy, but disabled from permanent joint damage. Others may be transferred for resettlement purposes.

* Paper read at a joint meeting of the Heberden Society and the British Association of Physical Medicine, Buxton, July 25 and 26, 1959.

Sex and Age Distribution

The ratio of males to females was 1:1·9. This was decidedly different from the figure for the whole unit, which was 1:1·4.

The age range (Table I) was wide—from 10 up to 78 years, but with a concentration in the 40–60 age group, 59% being in this group. Only 17% were over 60.

TABLE I

Age Range of Patients on Admission

	Years						
	10–20	21–30	31–40	41–50	51–60	61–70	70+
Percentage ..	2	8	14	26	33	15	2

Duration of Disease (Table II)

The majority of our patients have chronic disease, and only 6% had disease of less than one year's duration. In contrast, 65% had disease of over five years' duration.

TABLE II

Duration of Disease

	Years						
	—1	—2	—3	—4	—5	—10	10+
Percentage ..	6	7	7	9	8	28	37

Time Off Work or Home Duties (Table III)

This gives a more realistic impression of the duration of the patients' disability. Although only 6% had disease of less than one year's duration, 64%

TABLE III

Period Off Work or Home Duties

	Years							
	0	—1	—2	—3	—4	—5	—10	10+
Percentage ..	27	37	16	8	4	5	1	2

had not been sufficiently disabled to be off work for more than one year. In contrast to the 65% who had disease of over five years' duration, only 3% had been off work for more than five years. Our group, then, though suffering from chronic disease, was on the whole a relatively recently disabled group, 80% having less than two years' major disability.

Stay in Unit (Table IV)

The stay in the rehabilitation unit was surprisingly short, and 69% were discharged within three months. However, this figure does not take into account

TABLE IV

Stay in Unit

	Months					
	—1	—3	—6	—9	—12	12+
Percentage	15	54	20	10	1	—

time spent in the hospital on the other units, and so does not represent the total duration of the patients' treatment.

RESULTS

Functional Capacity

Six grades (0–5) were used, and the patients were classified on admission and discharge. Follow-up presented insurmountable difficulties, as few of our patients live within reasonable reach of the hospital.

Disability Grading

Grade	
0	No disability
1	Minor handicap
2	Light work, normal life
3	No work, socially independent. Some housework
4	Able to dress; toilet activities
5	Completely disabled

Our records show that on admission over 55% were very seriously disabled, and the proportion had fallen to less than half this figure on discharge (Table V). On admission only 14% were fit for any work, and on discharge 51% were considered fit for work.

TABLE V

DISABILITY ON ADMISSION AND DISCHARGE OF 988 PATIENTS WITH RHEUMATOID ARTHRITIS

Grade of Disability	On Admission	On Discharge
	%	%
0	0	2
1	1	14
2	13	35
3	31	24
4	30	15
5	25	10

Analysing the two sexes separately (consecutive samples of 100 of each), we find that the men and women reach us at different stages of disability (Table VI). The women were decidedly more disabled on admission (and on discharge)

TABLE VI

DISABILITY ON ADMISSION AND DISCHARGE OF 100 MALE AND 100 FEMALE PATIENTS WITH RHEUMATOID ARTHRITIS

Grade of Disability	Males		Females	
	On Admission	On Discharge	On Admission	On Discharge
0	0	6	0	4
1	2	22	3	19
2	12	40	9	30
3	40	20	21	22
4	34	9	46	19
5	12	3	21	6

than the men: 67% of the women were in Grades 4 and 5 on admission, compared with 46% of the men. It is clear that they all come into hospital when their disability becomes a major nuisance—the men when they are unable to work, and the women when they need looking after in the home.

OCCUPATION RECOMMENDED ON DISCHARGE (Table VII)

On discharge the patients were graded into three classes: (*a*) fit for their own job; (*b*) in need of lighter (different) work; and (*c*) unfit for work. There was great difficulty in making this assessment for the women, as the majority (76%) were housewives or did no work at all, and only 24% had had any paid

TABLE VII

OCCUPATION RECOMMENDED ON DISCHARGE

Recommendation	Males	Females
	%	%
Own job	39	44
Lighter work ..	43	30
Unfit	18	26

job within five years of admission. We consider this grading more satisfactory for the men than grading them according to their ability to do heavy, intermediate, or light work.

For women the major problem is housework, and all the women pass through the household training unit for assessment and training. On discharge about 65% were able to run their homes with the help normally available (Harris, 1955).

RESETTLEMENT

WOMEN

The women present only a minor problem in regard to resettlement, as the majority return to housework (for which we have retrained them) in their own homes. Out of 119 women with R.A. reported elsewhere (Harris, 1958), 34 had worked within five years of admission to the unit, and 20 of these returned to work, all to jobs within their previous sphere of employment (except two girls who had not previously worked, who were given clerical training). In general, then, their previous jobs had been suitable for them to return to after rehabilitation. The main problem was not the job, but getting to it.

MEN

The men who were considered fit for their own job were usually no problem, particularly if they were skilled workmen or had long service with their employers. Recently this situation has not been quite so happy, because of the recession in some of the basic industries in the district. In many areas no jobs exist in the trade which the man has followed. Of the men 39% were considered fit for their own job and 18% were unfit for work. The third group, of 43%, needed lighter work, and these men were interviewed at resettlement clinics at which our local disablement resettlement officer (D.R.O.), a member of the medical staff, the almoner, and other interested ancillary staff were present. We are fortunate in that one member of our unit staff also holds an industrial medical post, so that special experience is available.

All subjects going through the resettlement clinic are followed up by the Ministry of Labour at three months (Table VIII). Analysing 100 successive men

TABLE VIII

ANALYSIS OF 100 CASES OF R.A. THREE MONTHS AFTER INTERVIEW AT RESETTLEMENT CLINIC

Finding	No. of Patients
Satisfactorily resettled ..	36
In training	4
Unemployed	16
Sick	34
No information	10

with R.A. who had been through the clinic, we found at three months that 36% were satisfactorily resettled and 4% were in training; 34% were labelled "sick". A relapse rate of 34% in three months appears most unlikely.

FOLLOW-UP

With the help of the Ministry of Labour we were able to follow up a group two to three years after interview at the resettlement clinic (Table IX). All these subjects were seen and personally interviewed by their local D.R.O.s. From the

TABLE IX

FOLLOW-UP TWO TO THREE YEARS AFTER DISCHARGE OF PATIENTS WITH R.A.

	Men	Women	Total	%
Satisfactorily settled	18	2	20	40
Partially resettled	3	1	4	8
In training	—	—	—	—
Temporarily sick	1	2	3	6
Unemployed	—	—	—	—
Sick	18	4	22	44
Dead	1	—	1	2
Untraced	1	—	1	2
Total	42	9	51	100

results it appears that subjects who were resettled adequately have kept in work. More than half the patients with R.A. who went through the resettlement clinic were in stable employment. The remarkable blank column for "Unemployed" (Table IX), contrasting with the 44% labelled "Sick", is, I am sure, a Ministry of Labour euphemism.

The women placed in employment were previously skilled clerical workers and got back their own job. One "partially resettled" in hotel work has since married and given up her paid employment.

The men, in general, returned to a job in their own industry, but almost invariably to less skilled and lower-paid jobs—for example, a coal-face worker became a surface haulage hand; a railway platelayer did light portage.

The jobs of the 42 men in this survey were closely studied and graded according to manual severity and skill into heavy, intermediate, and light, and into skilled, semi-skilled, and unskilled. There was a marked shift in skill and physical effort between their initial and final employment. No subject was placed in heavy work, and in the North of England, with its concentration of heavy industry, this seriously reduced employment prospects for our patients. More surprising, and more serious from the national viewpoint, is the loss of skilled ability, as only 20% of the men were placed in skilled jobs, compared with an initial 52%. (See Table X.)

TABLE X

JOB GRADING PREVIOUS TO ILLNESS AND ON RESETTLEMENT (MEN)

Grade	Initially	Finally
	%	%
Skilled	52	20
Semi-skilled	16	44
Unskilled	32	36
Heavy	36	0
Medium	56	24
Light	8	76

DISCUSSION

Our results compare favourably with those reported elsewhere. The over-all figures are rather similar to those of Duthie *et al.* (1955), from Edinburgh, but they were dealing with a different group of patients. Among their male cases 36% were admitted within one year of the onset of disease, whereas only 6% of our men had disease of comparable duration. This is a group which can be expected to do extremely well, and thus our series is loaded unfavourably.

The New York Arthritis and Rheumatism Foundation has published its rehabilitation and resettlement results (Acker, 1956). In a three-year period

212 patients with R.A. were referred for training and 159 accepted as suitable. Of these, 31 were later rejected and 52 failed to complete the course. It is clear that their material was very highly selected. The total number placed in work was 62, and 14 were referred elsewhere for training. Accepting these as being eventually resettled, then 76 out of 159 were resettled—i.e. 42%, a similar figure to our own. Half went back into their previous field of employment. The highest single group (22) went into clerical work, and the next highest (19) into semi-skilled light industrial work.

A report on resettlement from the rehabilitation centre of the University of Pennsylvania (Heather, 1958) includes 20 patients with R.A., 40% of whom became gainfully employed. Hoberman (1958), at Westhaverstraw, reported the results of rehabilitating the "permanently and totally disabled" patient, including a group of 37 with R.A. Of these, 62% made substantial gains, and less than 20% remained completely helpless.

Our own results thus appear to compare favourably with those reported elsewhere.

CONCLUSIONS

Our results demonstrate that the rehabilitation and resettlement of the patient seriously disabled by rheumatoid arthritis is a practical proposition. The patients admitted to the rehabilitation unit were highly selected, in that they were too disabled to be handled in ordinary general hospitals. Indeed, many patients were transferred to our care from hospitals with well-established and well-known rheumatism units. Carefully planned and individual rehabilitation programmes are necessary, and a team approach is essential. Only 10% of our patients failed to achieve limited independence.

Our resettlement figures demonstrate the importance of early and careful job placement, the critical period being immediately after the patient is discharged from hospital. Virtually all the subjects placed at work within three months of discharge from hospital were still at work two to three years later.

SUMMARY

In a five-year period 988 in-patients with rheumatoid arthritis were treated in a rehabilitation unit. The majority had chronic disease (65% of over five years' duration), but relatively recent serious disability. On admission 55% were very disabled, and only 14% fit for any work.

On discharge 25% were very disabled and 51% fit for some work. When a change of job was necessary the patient was considered at a resettlement clinic. Follow-up two to three years after discharge showed that more than half these subjects were still in stable employment.

Acknowledgments

I wish to acknowledge the help and co-operation of my colleagues, Dr. H. S. Barber, Mr. J. C. F. Cregan, Professor J. H. Kellgren, and Dr. J. Sharp; also Miss Thomas, A.M.I.A., Dr. A. H. Wilson, and Mr. J. Sleight (Ministry of Labour, Buxton), who have jointly conducted the majority of our resettlement clinics.

References

Acker, M. (1956) *Arch. phys. Med.*, **37,** 743.
Duthie, J. J. R., Thompson, M., Weir, M. M., and Fletcher, W. B. (1955) *Ann. rheum. Dis.*, **14,** 133.
Harris, R. (1955) *Ann. phys. Med.*, **2,** 201.
——— (1958) *Trans. Ass. industr. med. Offrs*, **8,** 115.
Heather, A. J. (1958) *Amer. J. phys. Med.*, **37,** 237.
Hoberman, M. (1958) *Arch. phys. Med.*, **39,** 237.

ORIGINAL PAPER

EFFECTS OF DELAY IN REHABILITATION OF FRACTURES OF TIBIA AND FIBULA

By J. G. PARISH

From the Durham Miners' Rehabilitation Centre, Chester-le-Street, Co. Durham

A SURVEY of 555 patients with fractures of the shafts of the tibia and fibula treated at R.A.F. Medical Rehabilitation Units, Chessington and Collaton Cross (Nichols and Parish, 1959) emphasized the importance of intensive treatment in the first two to three weeks after removal of the plaster. Patients arriving later than the third post-plaster week required considerably longer periods of treatment than the remainder.

In the present study the effect of delay in starting in-patient rehabilitation has been further investigated in a series of 26 miners with similar fractures treated at the Durham Miners' Rehabilitation Centre, Chester-le-Street, between July, 1957, and March, 1959. The results presented here, and the opinions expressed, are based on a study of the records of these 26 miners, but for comparison some figures taken from the previously published report referred to above are also included.

DETAILS OF SERIES

The causes of accident are presented in Table I, with figures for the R.A.F. patients for comparison. Of the miners 42% sustained a compound fracture, as compared with 10% of the R.A.F. patients.

The age distribution is shown in Table II. The majority of the miners

TABLE I

TYPES AND CAUSES OF ACCIDENT

	Miners	R.A.F.
Mining accidents	68%	—
R.A.F. Service accidents	—	6%
Motor-cycle accidents	8%	34%
Other road accidents	12%	7%
Football (Rugby and Soccer) ..	—	33%
Other causes	12%	20%
Total	100%	100%

(84%) were over the age of 30 years, whereas most of the Service patients (90%) were under this age.

TABLE II

AGE DISTRIBUTION

Age Group (Years)	Miners	R.A.F. Patients
16–19	0	33%
20–29	16%	57%
30–39	42%	10%
40–49	15%	
50–59	27%	0

METHOD OF TREATMENT

The method of treatment and assessment of the progress of the miners were similar to those adopted for patients with tibial shaft fractures at R.A.F. rehabilitation units described by Parish (1957) and by Nichols and Parish (1959). The treatment programme was divided into periods for class exercises, weight-resistance exercises, physiotherapy, and remedial games, and lasted six hours per day. Activities were graded into early, intermediate, and late stages according to the fitness of the patients. The progress of the patients was recorded on special proformas (Parish, 1957).

RESULTS

The term "mobilization time" has been adopted to describe the number of weeks from the removal of plaster until the patient is fit for discharge. The effect of the time of arrival at the rehabilitation centre on the average mobilization time is shown in Table III. In the R.A.F. series, 86% of the patients had started treatment at the rehabilitation centres either in plaster or within three weeks of removal of the plaster. The average mobilization time for these patients was nine to ten weeks. On the other hand, only 16% of the miners started treatment during this period, but the mobilization time was again about nine weeks. The majority of the miners (84%) arrived more than three weeks after removal of their plaster, against only 14% of the R.A.F. patients, but the mobilization time was similar—18 and 16 weeks respectively. The older age groups of the miners and the greater incidence of compound fractures did not affect the mobilization period as much as did the time of arrival at the centre.

TABLE III

EFFECT OF TIME OF TRANSFER TO REHABILITATION CENTRE ON MOBILIZATION PERIOD OF FRACTURES OF SHAFTS OF TIBIA AND FIBULA

Time of Transfer to Rehabilitation Centre	R.A.F. Series			Miners		
	No. of Patients	%	Average Period of Mobilization in Weeks	No. of Patients	%	Average Period of Mobilization in Weeks
At rehabilitation centre in plaster	370	67	9	1	4	4
Arriving at rehabilitation centre within 21 days of removal of plaster ..	106	19	10	3	12	9
Arriving at rehabilitation centre more than 21 days after removal of plaster	79	14	16	22	84	18
Totals	555	100	Average 10	26	100	Average 16½

PERFORMANCE OF FUNCTIONAL TESTS

The average time taken by patients from the removal of the plaster until they have been able to perform standard tests of ability to stand on the toes of the injured leg, to walk, and to run is indicated in Table IV. The R.A.F. figures in this table are taken from a detailed survey of 74 diaphysial fractures (Parish, 1957) and are similar to those for the miners, except that the miners took longer to perform the toe-springing tests. This is probably due to differences in age and the nature of employment. Patients arriving in the first three post-plaster weeks regained their agility and normal gait in about half the time of those who arrived later than this.

Patients immobilized for long periods in plaster take longer to recover normal function (Nichols and Parish, 1959); analysis of plaster times in Table V shows that this may be a factor in delaying the performance of these tests in the "late arrival" groups.

However, figures are available for a series of 18 R.A.F. patients immobilized in plaster for 21 weeks and treated at the rehabilitation centre in plaster (Parish, 1957). The "late arrival" groups still took, on an average, at least three to six weeks to reach the corresponding stage in the tests of function compared with this plaster-treated group. These figures also suggest that two weeks should be added to the figures of the "early post-plaster arrival" groups to allow for the shorter plaster times.

TABLE IV

COMPARISON OF PERFORMANCE OF FUNCTIONAL TESTS AFTER TIBIAL SHAFT FRACTURES IN R.A.F. PATIENTS AND MINERS

Test	Average Time in Weeks from Removal of Plaster to First Performance of Test			
	In Patients Arriving at Rehabilitation Centre Within 3 Weeks of Removal of Plaster		In Patients Arriving at Rehabilitation Centre Over 3 Weeks after Removal of Plaster	
	R.A.F.	Miners	R.A.F.	Miners
Ability to stand on toes of injured leg:				
1. With moderate support ..	3	4	6	11½
2. With two-finger support ..	3½	4½	8	13
3. Just without support ..	4	5	9½	15
4. Readily without support ..	6	7½	12½	17*
Walking:				
1. With even steps and slight limp	5	6	13	14
2. Normally	7	7	14*	17*
Running:				
1. With uneven steps and limp ..	4½	4½	12	13
2. With even steps and slight limp	7	7	15	16

* Not all patients could perform this test on discharge. Figures given for the remainder.

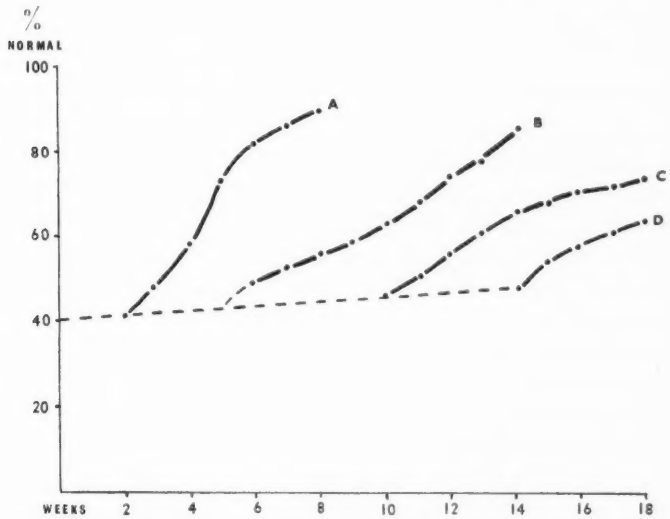
TABLE V

DURATION OF IMMOBILIZATION IN PLASTER

Time of Arrival for Rehabilitation	R.A.F.		Miners	
	No. of Patients	Average Plaster Immobilization Time (Weeks)	No. of Patients	Average Plaster Immobilization Time (Weeks)
Within 3 weeks of removal of plaster	17	14½	4	14
Over 3 weeks after removal of plaster	11	21	22	20½

Calf-muscle Power

The recovery of calf-muscle power during treatment at the rehabilitation centre is shown in the diagram, which indicates the mean rate of recovery of four groups of patients arriving in the first, second, third, and fourth months, respectively, after removal of plaster. Calf-muscle power was measured weekly by recording the maximum weight the patient could lift on plantar flexion of the foot with the leg fixed. The power of the injured leg is expressed as a percentage of the normal calf-muscle power in the diagram. Graphs made from readings of



Graph showing recovery of calf-muscle power in patients arriving at rehabilitation centre (A) one, (B) two, (C) three, and (D) four months after removal of plaster.

direct calf-muscle power show similar characteristics. Patients arriving in the first post-plaster month show rapid recovery of power, but in subsequent monthly periods the rate of recovery becomes progressively less. Those patients who arrived in the fourth month show only a small increase in the rate of recovery over the estimated pre-rehabilitation rate indicated by the dotted line.

All patients undergo a daily period of weight-lifting exercises to build up the calf muscles, following the system devised by Clements (1956). The late arrivals show a poor response to this regimen. It has been suggested that isometric resistance exercises may be the answer to this problem (Nichols and Parish, 1959).

Physiotherapy before Admission to Centre

The methods of physiotherapy employed before the patients arrived at the rehabilitation centre were distributed as follows:

Treatment	No. of Patients
Knee and ankle mobilizing exercises	18
Radiant heat	10
Aeration baths	8
Quadriceps and/or calf weight-resistance exercises	8
Walking instruction	6
Faradism	1
Wax baths	1
No treatment	3

The over-all effect of these forms of treatment was that the majority of patients arrived at the centre with a good range of knee and ankle movements. The power of dorsiflexion, supination, and pronation of the foot was usually satisfactory. In contrast, the ability to spring on to the toes was poor or absent, even in the patients who were having calf-muscle resistance exercises. These patients had not been taught how to adapt for normal progression the calf-muscle power developed. The lack of walking instruction was reflected by the frequency with which patients arrived walking with a severe limp and with the foot rotated outwards. This is the position which is usually adopted when the calf muscle is paralysed. Only if the position of the foot is corrected can walking help to build up calf-muscle power and co-ordination.

Post-plaster Oedema

In a previous paper (Nichols and Parish, 1959) it was suggested that post-plaster oedema was the most important cause of post-plaster stiffness and delayed mobilization. In the present series 25% of patients developed post-plaster oedema, but the series is too small for this figure to be reliable.

Disposal

The ultimate disposal of the miners compared with the R.A.F. patients was as follows:

Disposal	Miners	R.A.F.
Pre-accident employment	50%	77%
Modified employment	50%	18%
Invalided from service	—	5%

DISCUSSION

It has been shown that there is no significant difference between the average mobilization times of patients treated at rehabilitation centres for long or short periods in plaster and of those arriving for treatment within three weeks of removal of plaster (Parish, 1957; Nichols and Parish, 1959). The latter group caught up with the plaster-treated patients in the rate of performance of the tests of function. The average mobilization time of patients arriving later than the third post-plaster week was significantly increased as compared with the remainder. The slower rate of recovery of these patients was attributed to the increased incidence and delay in dispersion of oedema. But it was suggested that oedema and calf-muscle action were probably closely interlinked, since the calf muscle acts as a pump which aids dispersion of the oedema.

The influence of other factors which may affect the rate of recovery, such as the type of reduction, open or closed injuries, compound fractures, and so on, was found to be slight when the plaster immobilization period was constant, as was the case in the earlier surveys. There was no evidence that recovery was delayed in any of the miners as a result of compensation claims.

In the present study a close correlation has been demonstrated between the rate of recovery of a relatively small group of miners and that of larger groups of R.A.F. patients. The principal difference between the groups lies in the slower recovery of toe-springing ability in the miners, which may be due to their higher age groups. On the other hand, this difference should not prevent a general application of the important finding that calf-muscle development declines when rehabilitation is delayed. The relation of the calf muscles to injuries around the ankle-joint is probably similar to that of the quadriceps muscle to knee injuries. At rehabilitation centres particular attention is paid to the development of calf-muscle power and co-ordination in normal activities. The more rapid recovery of patients treated at rehabilitation centres in the early post-plaster period is probably partly a result of the emphasis on calf-muscle development and partly due to more effective control of post-plaster oedema. There is also some evidence that the end-results are better when rehabilitation is started early (Parish, 1959). In this survey 50% of the miners returned to their pre-accident work; the remaining 50% were found alternative employment which put less strain on the injured leg. Early intensive treatment should result in a greater proportion of miners returning to their normal jobs as well as reducing the time they are totally unfit for work.

SUMMARY

The results of rehabilitation of 26 miners with fractures of the tibia and fibula treated at the Durham Miners' Rehabilitation Centre between 1957 and

1959 have been analysed. Comparison has been made with a previous series of 555 patients with these fractures treated at two R.A.F. rehabilitation centres between 1946 and 1956.

The majority of the miners (84%) did not arrive at the centre until more than three weeks after the plaster had been removed, and required considerably longer periods of treatment than patients arriving earlier. Corresponding groups of R.A.F. patients showed almost identical treatment times. Patients arriving for rehabilitation in the first three post-plaster weeks regain their agility and normal gait more rapidly than the remainder.

Measurements indicate that calf-muscle power develops progressively more slowly the longer full-time rehabilitation is delayed.

Analysis of previous treatment suggests that the emphasis has been placed on joint mobilization rather than on development of calf-muscle power and co-ordination as practised at the rehabilitation centre.

ACKNOWLEDGMENTS

I wish to thank Dr. Zinovieff and Sqdn.-Ldr. Nichols for advice and encouragement; my orthopaedic colleagues at the centre, Mr. Williams and Mr. Berry, for their co-operation; and Mrs. N. M. Dodson, M.C.S.P., who supervised the measurements of calf-muscle power.

REFERENCES

CLEMENTS, M. (1956) *The Remedial Gymnast*, **6**, 3.
NICHOLS, P. J. R., and PARISH, J. G. (1959) *Ann. phys. Med.*, **5**, 73.
PARISH, J. G. (1957) M.D. Thesis, University of Edinburgh.

CLINICAL REPORT

STRESS FRACTURE OF THE CALCANEUS

By STEPHEN MATTINGLY

From the Middlesex Hospital, London

STRESS or fatigue fractures may affect almost every bone in the body, although a march fracture of a metatarsal is perhaps the one which is most commonly diagnosed. Stress fractures of the calcaneus have been described in army recruits, but it seems likely that they are often missed even in military personnel. The following case history may therefore be of interest.

CASE HISTORY

The patient, a woman of 48, complained of pain in the left ankle which was aggravated by weight-bearing and walking and relieved by rest. Her symptoms had come on suddenly as she got out of bed three weeks previously, a severe pain shooting up the left leg from the heel; after three days the ankle appeared swollen.

Examination showed the left ankle to be swollen but cool, and, though the patient complained of pain at the extremes of flexion and extension of the ankle-joint, movements of the foot were otherwise normal. Radiographs of the left foot and ankle appeared to be normal. No diagnosis was made, although early tuberculous arthritis was suspected as the patient had had a nephrectomy for renal tuberculosis when she was 35 years old. She was told to rest at home for three weeks, supporting the ankle with a crêpe bandage, and was supplied with a pair of elbow crutches to get around the house.

Three weeks later the left ankle was less swollen and much less painful; the heel was tender, especially on its lateral aspect. Radiographs (Plate XIII) now showed a stress fracture of the left calcaneus. The patient was told to rest for a further three weeks and a sponge-rubber pad was fitted into the heel of the left shoe. Six weeks after her first attendance, and nine weeks after the onset of pain, the swelling had disappeared, the heel was slightly tender, and the foot ached only after prolonged weight-bearing. The patient returned to her work as a laboratory assistant. She reported at intervals for the next fifteen months, and when last seen had experienced no further trouble with the foot. Callus at the fracture site was still visible in radiographs taken five months after the onset of symptoms, but a year later radiographs of the left foot appeared to be normal.

Laboratory investigations gave the following results: haemoglobin 97% (Haldane); erythrocyte sedimentation rate 15 mm. in 1 hour (Wintrobe); white-cell count normal; serum calcium 9·6 mg. and 10·1 mg. per 100 ml., with inorganic phosphates 3·1 mg. and 2·9 mg. per 100 ml., and serum alkaline phosphatase 7·1 and 7·5 King–Armstrong units.

DISCUSSION

Stress fractures of the calcaneus have been described in three groups of American Army and Marine Corps recruits (Hullinger, 1944; Winfield and Dennis, 1959; Leabhart, 1959). More than 200 cases have now been reported. It is evident that they commonly occur during the first few weeks of training, especially in the older and less athletic recruits, and may result from excessive marching and jumping over obstructions on assault courses. The onset is usually gradual, but may be sudden, with swelling over the medial and lateral aspects of the calcaneus and local tenderness, presumably at the site of the fracture. Leabhart (1959) found that fluid could often be palpated in, and sometimes aspirated from, the region of the precalcaneal bursa deep to the Achilles tendon. Radiographs were usually negative for the first two to four weeks, and then a dense line of sclerotic bone appeared in the calcaneus, anterior and parallel to its posterior margin. The fractures seemed to involve only cancellous bone, the cortex appearing intact, though a periosteal reaction was sometimes seen. Stress fractures of the calcaneus in these army recruits were often bilateral and occasionally multiple. The diagnosis was frequently missed, the differential diagnosis including tenosynovitis, arthritis of the ankle and subtaloid joints, contused heel, and neurosis. Rest from weight-bearing was the most effective treatment. After a few days in bed, patients were allowed to walk with elbow crutches for a week or two, the heel being cushioned by a sponge-rubber pad. Early return to work often resulted in a recurrence of symptoms, though most recruits could return to full duty after two months.

Stress fracture of the calcaneus is probably a common lesion affecting American Army and Marine Corps recruits. It is rarely diagnosed in Great Britain, possibly because radiographs appear normal for the first few weeks, and the diagnosis is therefore not suspected. It must be considered, however, in the differential diagnosis of pain in the heel, and further radiographs should be taken after an interval of not less than three weeks. Rest from weight-bearing on the affected foot, either in bed or on elbow crutches, for several weeks seems to be the most effective treatment.

References

HULLINGER, C. W. (1944) *J. Bone Jt Surg.*, **26,** 751.
LEABHART, J. W. (1959) Ibid., **41A,** 1285.
WINFIELD, A. C., and DENNIS, J. M. (1959) *Radiology*, **72,** 415.

PLATE XIII

Lateral radiograph of the left foot, showing stress fracture of the calcaneus. A dense line of sclerotic bone lies anterior and parallel to the posterior border of the calcaneus.

PLATE XIV

Simple tilt chair for patients with fixed hips and knees or with major leg and trunk weakness.

[R.H.

NEW APPLIANCE

A SIMPLE TILT CHAIR

GETTING in and out of a chair may be a major problem for the seriously disabled. Raising the height of a chair or providing it with arms may be helpful for the patient with stiffness or weakness of the lower limbs. An additional measure we have found useful is a tilting seat.

The photographs (Plate XIV) are self-explanatory. A seat is swivel-mounted on a rigid chair frame so that approximately one-third of the seat projects in front of the fulcrum. (The swivel can be made from a strong pair of hinges.) Retainer blocks screwed to the chair frame determine the angle of swivel—usually 40 degrees is adequate. The subject backs up to the chair, and when his thighs catch against the projecting leading edge of the seat this pivots around its fulcrum. The seat then swings into contact with the patient's buttocks. Body-weight is then transferred to the seat, and as the weight is applied distal to the fulcrum the seat swings down, seating the patient, who then shuffles farther back on the seat into a stable position. In getting up the process is reversed.

This chair is easily made from simple material by the patients themselves. We have made about four a year, principally for patients with fixed hips and knees (rheumatoid arthritis or ankylosing spondylitis) and for major leg and trunk weakness (e.g. poliomyelitis).

ACKNOWLEDGMENTS

I am indebted to many members of the Occupational Therapy and Physiotherapy Departments for valuable suggestions in designing this chair, and to Mr. J. Cotterill who made the prototype.

RONALD HARRIS

Devonshire Royal Hospital,
Buxton.

REVIEW SERIES

SUPPURATIVE ARTHRITIS

By D. A. BREWERTON and C. W. MANNING

From the Royal National Orthopaedic Hospital and the Institute of Orthopaedics, London

SUPPURATIVE arthritis is rare, but it is always important because joint destruction can occur rapidly, and immediate diagnosis and treatment are essential.

AETIOLOGY

Infection may reach a joint cavity by one of three routes: (1) haematogenous spread; (2) direct extension from infection of tissue in close proximity to the joint, in particular from osteomyelitis of the metaphysial bone; and (3) introduction from without: from compound fractures involving the joint, penetrating wounds including aspiration or introduction of substances into the joint by injection, and elective surgery.

PATHOLOGY

Suppurative arthritis has been described as following infection by a large range of pathological organisms; any organism which can cause septicaemia may lead to joint suppuration. Collins (1949) has shown that, in post-mortem examinations of patients dying of pneumococcal lobar pneumonia, inflammation and oedema of the synovial membranes was a regular finding.

Inge and Liebolt (1935), Ellis (1950), Altemeier (1952), and Watkins *et al.* (1956) found that the staphylococcus was the infecting organism in up to 50% of the cases reviewed by them. To-day pneumococcal pneumonia has almost disappeared and streptococcal infection is no longer the menace it used to be. On the other hand, staphylococcal infection has become more difficult to control as antibiotic resistance has developed, and it now accounts for almost all haematogenous suppurative arthritis in older children and adults.

Penetrating injuries can introduce a variety of infecting organisms, but even in these cases *Staphylococcus aureus* is the most common pathogen. In infancy the umbilical cord is the common portal of infection, and many different organisms, including haemolytic streptococci and pneumococci, have been reported as being responsible. However, in recent years the prevalence in hospitals and obstetric units of staphylococci resistant to most antibiotics has made this organism by far the most common and the most dangerous.

When infection is established, the synovial tissues become hyperaemic and oedematous, and there is outpouring of synovial fluid rich in leucocytes and

fibrin. The whole joint surface becomes yellow-grey in colour and loses its normal glistening appearance. Granulation tissue appears at first at the articular margins, and cartilage is undermined and detached from the underlying bone.

It was shown by Phemister in 1924 that chondrolysis in pyogenic arthritis is caused by digestive action of a proteolytic ferment, which he thought was derived from polymorphonuclear leucocytes. Lack (1959) has shown that the rapid chondrolysis occurring in infections by *Staph. pyogenes* and haemolytic streptococcus is mainly due to activation of plasminogen by kinases produced by these organisms. In infections by pneumococci and gonococci, activation of plasminogen may be produced with consequent chondrolysis, but these processes are much slower and are due to activators released by disintegration of leucocytes, as originally suggested by Phemister. In joint tuberculosis no direct proteolytic attack on cartilage occurs. However, if a joint with primary tuberculous infection becomes secondarily infected by pyogenic organisms rapid chondrolysis ensues. This was a common complication of tuberculous infection before antituberculous chemotherapy was available. Nowadays spontaneous pointing of a tuberculous abscess is rare, and secondary infection of joints through a tuberculous sinus is becoming less and less common.

At a later stage of joint suppuration the intra-articular and capsular ligaments become softened and may be stretched by the intra-articular fluid under tension. Spontaneous dislocation may occur, particularly in the hip-joint. The intra-articular abscess may rupture through the joint capsule, find its way through the tissue planes, present subcutaneously, and eventually discharge through the skin.

Articular cartilage does not regenerate and healing takes place by granulation and cicatrization, and so the eventual disability depends upon the extent of the damage caused by the infection. The range of movement may vary from full range to a fibrous ankylosis with little or no movement. In virulent infections spontaneous bony ankylosis may result.

Any joint may become the seat of a suppurative arthritis following haematogenous infection. The knee and hip are most commonly affected, together accounting for between 60% and 70% of all infections. Watkins, Samilson, and Winters (1956) give the following distribution of suppurative arthritis: knee, 32%; hip, 30%; elbow, 15%; ankle, 5%; small joints of hands, 5%; shoulder, 3%; multiple joints, 5%.

Apart from gunshot wounds, penetrating injuries are most common in superficial joints, particularly the knee from kneeling on sharp objects, and this joint is prone to serious damage in traffic accidents. Also commonly affected are the small joints of the hand; for instance, when a fist comes into forcible contact with an opponent's teeth the metacarpo-phalangeal joints may be

penetrated and become infected. The small joints of the fingers are also liable to direct spread of infection from flexor tendon sheaths.

CLINICAL PICTURE

The diagnosis of a typical case is not difficult. At first there may be little general disturbance, but severe toxicity with high fever occurs within a few hours or days, the speed of reaction depending on the virulence of the organism and the extent of the invasion. Initial discomfort in the joint is soon followed by swelling, increased temperature, redness of the skin over superficial joints, and reflex spasm of muscles around the joint. The affected joint is held in the position which allows maximum volume in the synovial cavity: 30–40 degrees of flexion of the knee, or 20–30 degrees of flexion, abduction, and external rotation of the hip. This position is rigidly maintained by muscle spasm, and attempted active or passive movement of more than a few degrees may produce severe pain and increased muscle spasm. However, in children particularly, a range of movements of perhaps half normal does not exclude suppurative arthritis, and the whole picture may be obscured by early, and possibly inadequate, antibiotic therapy before the diagnosis has been made.

It is not in typical cases that difficulty in diagnosis is encountered, but in those with a reduced reaction to joint infection. This may occur in the newborn (Samilson *et al.*, 1958) and the elderly, in patients already receiving treatment by antibiotics or steroids or who have had intra-articular injections of steroids, and in patients with established rheumatoid disease.

In the newborn the diagnosis is usually clear, but at times the systemic reaction can be slight until joint destruction is well advanced, so that an infection of the femur and hip-joint may become evident only when a secondary abscess presents in the buttock. In the elderly the reaction to infection may be similarly diminished, so that unless aspiration is performed it may be assumed to be a monarticular synovitis or arthritis of the rheumatic type.

At any age, antibiotic therapy given before the diagnosis is established can be sufficient to obscure the diagnosis without preventing the process of joint destruction.

In recent years injections of steroids into joints have become commonplace, and often these are given with less attention to technique than used to be considered essential. While it is true that infections from this cause are unusual and large series have been reported with a very low incidence of infection (Hollander, 1953), this can be a serious complication, and there can be no doubt that it is occurring.

Introduction of hydrocortisone into a swollen joint may reduce the local protective response to bacteria, and then the diagnosis of suppurative arthritis

may be obscured both by the hydrocortisone and by the fact that the joint was already swollen before the suppuration. In our experience this has led to infections of rheumatoid joints being missed for periods up to several weeks. The other danger is that the mild response to infection may be misinterpreted as indicating a mild infection. It is difficult to decide what measures of injection technique are adequate to prevent infection in clinical practice—a point discussed by Glyn and Newton (1958). Kaplan (1954), after describing six cases of septic arthritis following steroid injections, suggested a return to the routine of washing and shaving the skin, surgical paint, towels, gloves, autoclaved syringe and needle, and fresh materials for injections.

Kellgren *et al.* (1958) recently described twelve cases of suppurative arthritis complicating rheumatoid arthritis. Ten of these were due to *Staph. aureus* and two to coliform bacilli. In each case many joints were infected; in several there was suppuration of rheumatic nodules, and in three there was osteomyelitis. Only four of these patients had been treated with steroids. The obvious danger of this complication is that it could be interpreted as an exacerbation of the rheumatoid process. Although most of the cases reported had a high fever and rigors, at least one was afebrile with little systemic disturbance and a normal white blood count. Rigors when they occurred gave a useful pointer to the correct diagnosis.

DIFFERENTIAL DIAGNOSIS

In children acute non-specific "synovitis" is the commonest alternative diagnosis—particularly when it is the hip that is involved. In this condition there is usually little systemic reaction, and both the leucocyte count and the erythrocyte sedimentation rate are normal. Osteomyelitis, joint tuberculosis, rheumatic fever, and juvenile rheumatoid arthritis are also common alternative diagnoses, with leukaemia and haemophilia as possibilities.

In adults rheumatoid arthritis, osteoarthritis, ankylosing spondylitis, Reiter's disease, tuberculosis, and syphilis must all be considered, but gout and haemarthrosis are the two conditions most likely to resemble suppurative arthritis.

Joint aspiration will usually establish the diagnosis, and this should always be done if suppurative arthritis is a possibility.

INVESTIGATIONS

Joint fluid must be examined as soon as possible. Normally this is obtained by aspiration, but this may be difficult in some of the deeper joints, particularly the hip, and in this case surgical exposure and drainage should not be delayed.

Biopsy of synovial membrane and a lymph node from the regional drainage area can be performed at the same time.

The essential feature of the fluid in an infected joint is the cell response. If the response is predominantly polymorphonuclear, with a count of 20,000 cells per c.mm. or more, a coccal infection is probably present. With a high polymorphonuclear count the sugar content of the joint fluid will be reduced, but this finding is merely a reflection of the cell count and adds nothing to the diagnosis. A Gram stain may reveal intracellular cocci.

Culture is, of course, the main investigation, and several media should be used. Drug-sensitivity estimations are essential.

Blood cultures, erythrocyte sedimentation rate estimation, and white blood count should be performed; and certain serological tests may be helpful in staphylococcal infections, particularly the anti-alpha-haemolysin titre and the anti-Panton–Valentine (P.V.) leucocidin titre (Towers and Gladstone, 1958). The anti-P.V. leucocidin titre is sensitive to soft-tissue staphylococcal infections, whereas a high anti-alpha-haemolysin titre is suggestive of bone infection.

Although radiographs should be taken for future comparison, they are of no help in establishing the initial diagnosis.

TREATMENT

There is considerable controversy about whether a joint the seat of suppurative arthritis should be treated by continuous drainage, arthrotomy with primary wound closure, or aspiration only, with instillation of appropriate antibiotics. The decision must depend partly upon the extent of the infection and the viscosity of the intra-articular fluid. In general, the superficial joints, such as the knee, can sometimes be treated by repeated aspiration and instillation of drugs, but a deeply placed joint like the hip may be more difficult to treat in this way for technical reasons. Especially in children, it is vital to avoid serious intra-articular pressure in the hip, which can lead to cessation of blood flow in the synovial vessels and avascular necrosis of the head of the femur. If there is any doubt, the affected joint should be treated by open drainage, but in most cases primary wound closure is advisable to avoid the danger of secondary infection (Smith, 1951).

Another controversial issue in treatment is whether the affected limb should be rested or moved. In the past Wilhelms has stressed the importance of early active movement, including weight-bearing in the lower limbs, and others have supported this view (Heberling, 1941). In our view the affected joint should be rested on a suitable splint; for instance, if the knee is affected, a Thomas splint may be applied with skin traction to prevent the articular surfaces being firmly pressed against one another by muscle spasm. The position should be such that

no vicious contracture will result. It is essential to guard against spontaneous dislocation—especially with hip involvement, where 20–30 degrees of abduction should be maintained.

Intra-articular injections of antibiotics should be supplemented by full systemic doses of two antibiotics to which the infecting organisms have been shown to be sensitive. Intra-articular injections should be given once every twenty-four hours during the initial period of active inflammation, which will vary in duration with the virulence of the infecting organism; then the interval between injections should be steadily increased, and injections finally discontinued when the joint is painless, the signs of acute inflammation have subsided, and active movements may be permitted. The systemic antibiotic therapy should be continued for a much longer period, until the erythrocyte sedimentation rate and leucocyte count have returned to normal, and in any case for some weeks.

Once the infection has been overcome and muscle spasm is relaxed, controlled active muscle contraction can begin, and the patient can progress to gentle active movements as pain subsides.

Early adequate treatment should result in return of full joint function. In cases where cartilage destruction has resulted in loss of range of movement a decision about formal arthrodesis may have to be made, but this is usually better postponed for some months, and is indicated only for the relief of pain.

References

ALTEMEIER, W. A., and LARGEN, T. (1952) *J. Amer. med. Ass.*, **150,** 1462.

COLLINS, D. H. (1949) *The Pathology of Articular and Spinal Diseases*, p. 130. Arnold, London.

ELLIS, V. H. (1950) "Pyogenic Affections in Joints and Bones" in *Modern Trends in Orthopaedics*, ed. H. Platt, pp. 71-90. Butterworth, London.

GLYN, J. H., and NEWTON, D. R. L. (1958) *Ann. phys. Med.*, **5,** 176.

HEBERLING, J. A. (1941) *J. Bone Jt Surg.*, **23,** 917.

HOLLANDER, J. L. (1953) *Ann. intern. Med.*, **39,** 735.

INGE, G. A. L., and LIEBOLT, F. L. (1935) *Surg. Gynec. Obstet.*, **60,** 86.

KAPLAN, R. (1954) *J. Amer. med. Ass.*, **155,** 597.

KELLGREN, J. H., BALL, J., FAIRBROTHER, R. W., and BARNES, K. L. (1958) *Brit. med. J.*, **1,** 1193.

LACK, C. H. (1959) *J. Bone Jt Surg.*, **41B,** 384.

PHEMISTER, D. B. (1924) *Ann. Surg.*, **80,** 481.

SAMILSON, R. L., BERSANI, F. A., and WATKINS, M. B. (1958) *Pediatrics*, **21,** 798.

SMITH, A. K. (1951) *Bull. Hosp. Jt Dis.*, **12,** 459.

TOWERS, A. G., and GLADSTONE, G. P. (1958) *Lancet*, **2,** 1192.

WATKINS, M. B., SAMILSON, R. L., and WINTERS, D. M. (1956) *J. Bone Jt Surg.*, **38A,** 1313.

REVIEWS OF BOOKS

PRÉCIS D'ÉLECTROMYOGRAPHIE. By J. Dumoulin and Ch. Aucremanne. *Pp. 173. No price. Paris: Maloine. 1959.*

This manual of unusual format might well have been called "La Quintessence de l'Électromyographie". Indeed, all matter relevant to this type of investigation is presented in précis form with a generous bibliography of no fewer than 800 items, so that apart from being an excellent introduction to the subject it is also handy for tracing references.

It is abundantly and well illustrated with electromyograms typical of normality and pathology. The suggested method of drawing up a protocol of findings may appear somewhat cumbersome and lacking in flexibility, but it constitutes a good guide to the features to be observed and recorded. One or two statements are difficult to accept, as, for instance, the postulate at the bottom of page 60 to the effect that positive potentials may be the product of synchronized fibrillation potentials. Both their polarity and their wave-form militate against this contention. Again, the authors have been unfortunate in their choice of diagrams of muscles with their nerve and root supplies. From these it would seem that the eighth cervical and the first dorsal roots supply only the dorsal interossei, while the other intrinsic muscles of the hand derive their supply from the sixth and seventh cervical roots. It is doubtful whether this would pass unchallenged.

The second part, dealing with clinical electromyography, is a collection of brief clinical anecdotes representative of the various conditions capable of causing departures from the normality described in Part I, incongruously followed by five pages devoted to electromyographic recording during nerve and muscle stimulation. This, however, comes too late to make amends for the neglect to draw attention to the value of classical nerve and muscle testing as an essential complement to electromyography.

It is to be hoped that a work of this importance and stature, if translated into English, will have these wrinkles ironed out in the process.

P. BAUWENS

MANUAL OF OSTEOPATHIC TECHNIQUE. By Alan Stoddard. *Pp. 275. 50s. London: Hutchinson. 1959.*

In this book the osteopathic spinal lesion is defined as "a condition of impaired mobility in an intervertebral joint in which there may or may not be altered positional relations of adjacent vertebrae. When altered position is present, it is always within the normal range of movement in that joint."

The author believes, firstly, that the osteopathic lesion is a common cause of musculo-skeletal pain; secondly, that restoration of joint movement achieved by osteopathic methods is followed by symptomatic relief; thirdly, that it is possible on careful examination accurately to locate the spinal joint or joints which are at fault; and, fourthly, that with practice manipulation can be localized to the faulty joint. He emphasizes the importance of recognizing the existence of hypermobile joints. These are often to be found adjacent to those joints with restricted movement, and should not be manipulated.

Much of the book is devoted to describing, with the aid of photographs, the method its author uses to "diagnose" the lesion and to localize the manipulation.

The descriptions of the techniques are clear and the supporting photographs excellent.

If the author had been content to limit his text to the technical aspects of his subject all would have been well. Unfortunately, he devotes many passages to the aetiology of the osteopathic lesion. Much of this writing, especially the three pages in Chapter 2 describing animal experiments at Sunny Slope, is muddled and confusing, and is likely to prejudice and irritate many readers. The reviewer considers that, while a discussion on aetiology is obligatory in a textbook on the principles of osteopathy, it is not called for in a "manual of technique". In his opinion, it detracts from the value of a book which in other respects will undoubtedly be of use to those who believe that manipulation has a part to play in the practice of physical medicine and orthopaedics.

HUGH BURT

CLAYTON'S ELECTROTHERAPY AND ACTINOTHERAPY. Third edition. By Pauline M. Scott, M.C.S.P., T.E.T., T.M.M.G. *Pp. 418. 27s. 6d. London: Baillière, Tindall and Cox. 1958.*

This has been a popular textbook for physiotherapy students for many years. Miss Scott was associated with Dr. Clayton and assisted in the preparation of the previous edition. Considerable revision of the text has been carried out, and modern techniques such as the use of fluorescent-tube emitters of ultraviolet radiation have been included. There is also a section on radio interference from short-wave diathermy generators. In spite of this, the book suffers from the inevitable disadvantages of an established work revised while drastic changes in the use of and attitude toward its subject are taking place. Expansion of certain sections and the failure to omit others which are obsolete have resulted in a lack of balance and heaviness in the text which do not make for easy reading. Repetition is often necessary in a textbook to impress certain points and clarify others, but in this volume it becomes irritating, as in some sections it occurs on successive pages. It is a pity that the opportunity was not taken to give the lead to teachers by more drastic pruning of such subjects as iontophoresis, long-wave diathermy, and the old spark-gap generator, and the various forms of carbon-arc lamp. It is to be hoped that complete rewriting and rearrangement, with some newer illustrations to replace the museum pieces portrayed, will be carried out for the next edition.

These criticisms apart, the electrotherapy syllabus for the preliminary and intermediate examinations of the Chartered Society of Physiotherapy are adequately covered. The book will no doubt maintain its popularity among the teaching schools, where students are liable to plough devotedly through the text which their predecessors used, unless an enlightened teacher finds them a less wordy volume.

I. H. M. CURWEN

ABSTRACTS OF THE LITERATURE

Corticotrophin (ACTH) in Rheumatoid Arthritis. O. SAVAGE, P. S. DAVIES, L. CHAPMAN, J. WICKINGS, J. D. ROBERTSON, and W. S. C. COPEMAN. *Ann. rheum. Dis.*, 1959, **18**, 100.

The authors describe the results of treating 78 cases of severe rheumatoid arthritis with prolonged daily self-administration of corticotrophin. The disease activity had not been checked by rest, salicylates, or gold, and would have prevented these patients from carrying out their normal occupations. In 40 cases regular clinical assessments were made over a period of two years, and the degree of adrenal stimulation produced was assessed by estimating the 24-hour urinary excretion of 17-hydroxycorticosteroids. The dose of corticotrophin was regulated primarily by clinical response, but in view of variation in adrenocortical response the 17-hydroxycorticosteroid excretion was observed to minimize over-stimulation and side-effects.

Interesting patterns of response emerged [for which the original paper should be consulted], but the majority of the patients responded satisfactorily to a dose of 20 units ACTH daily. Improvement was maintained in 27 cases, and in 6 of them the drug was withdrawn without relapse. The results compare most favourably with those of the M.R.C./Nuffield Foundation cortisone–aspirin trial. The side-effects are compared with those in a group receiving oral steroid therapy. The incidence of peptic ulceration was markedly less with corticotrophin therapy, while that of "moon face", hirsuties, and osteoporosis was similar. There was a greater incidence of glycosuria, acne, and moderate hypertension. On withdrawal of corticotrophin untoward symptoms of adrenal insufficiency were not seen.

D. A. H. YATES

Advances in the Treatment of Arthritis and Chronic Rheumatism. S. J. HARTFALL. *Practitioner*, 1959, **183**, 455.

In this excellent monograph the author discusses in some detail and with an adequate bibliography the present status of treatment in the rheumatic and pararheumatic diseases. Physiotherapeutic measures are described and criticized, and the recent work on salicylates and gastro-intestinal bleeding is reviewed. Phenylbutazone and its newer analogues are discussed, together with the status of the antimalarial drugs. The new scheme of gold therapy is described in detail, and the relative advantages and disadvantages in the use of the various anti-inflammatory steroids, both systemically and by intra-articular injection, are reviewed.

B. G. B. CHRISTIE

Surgical Treatment of Cervical Osteoarthritis. R. W. RAND and P. H. CRANDALL. *Calif. Med.*, 1959, **91**, 185.

This article discusses surgery for cervical spondylosis by the anterior approach. It is claimed that a good exposure can be obtained for clearing the osteophytes from the intervertebral foramen, that the remaining degenerated disk substance can be easily removed, and that the subsequent inter-body fusion technique is safe and efficient. In cases where there was no cord involvement the authors have obtained excellent results, relief of pain being immediate and complete. They consider that relief of symptoms and signs attributable to myelopathy cannot be expected to improve much, but even here remarkable improvement could occur.

D. C. ARNOTT

Low Back Pain due to Arterial Obstruction. D. L. FILTZER and H. T. BAHNSON. *J. Bone Jt Surg.*, 1959, **41B**, 244.

Between June, 1952, and September, 1958, 60 patients were seen at the St. John's Hospital, Baltimore, with aorto-iliac obstruction proven by aortograph or operation, or both. Of these patients, 13 were found to have low pack pain with or without sciatica as a prominent symptom. Further study of these patients indicated that the low back pain was due to arterial insufficiency and responded to appropriate treatment.

The authors consider that differentiation between "orthopaedic" low back pain and "ischaemic" low back pain should not be difficult if the possibility of ischaemia is recognized and looked for both in the patient's history and at full examination.

P. J. R. NICHOLS

Studies on the Pathology of Low Back Pain. C. HIRSCH. *J. Bone Jt Surg.*, 1959, **41B**, 237.

This paper from the University of Uppsala is a review of the correlation between low back pain with structural changes in lumbar

intervertebral disks. The author refers to a number of investigations which have been carried out in Sweden since 1940, and discusses the clinical features, histological changes in the lumbar disks, comparative studies on disk degeneration in animals and man, the mechanical function of the disks, and the mechanism of pain. He concludes that disk degeneration begins as an avascular necrosis, starting early in the lower lumbar area because of mechanical stresses. The resulting mechanical disorder between annulus and posterior longitudinal ligament may cause tiredness and pain. Symptoms disappear when the disk is completely degenerated.

P. J. R. NICHOLS

Meralgia Paraesthetica. W. R. GHENT. *Canad. med. Ass. J.*, 1959, **81**, 631.

This paper sets out to review the scant literature on meralgia paraesthetica, to present another case, and to report a surgical method of treatment.

The pain of meralgia paraesthetica affects either leg with equal frequency. Its distribution is that of the lateral cutaneous nerve of the thigh, and paraesthesiae are associated. Symptoms are said to be present in the erect and supine positions only. At first, thigh flexion relieves the pain. The author argues that this mono-radicular pain must have a mechanical cause. The anatomy of the nerve is described in detail and possible local causes of the condition are discussed. A congenital abnormality of the inguinal ligament is accepted as the usual cause of pressure. In this the nerve passes between two fasciculi of the ligament instead of posterior to the whole ligament. This leads to "bow-stringing" of the nerve in the erect and supine positions. To resect the nerve below the ligament leaves the cause of the pain untouched; for cure, that part of the inguinal ligament lying posterior to the nerve must be divided.

D. C. ARNOTT

Basic Concepts about Shoulder–Arm Syndrome. J. W. PENDER. *J. Amer. med. Ass.*, 1959, **169**, 795.

This is a review of the various factors which the author regards as important in the causation of the shoulder–arm syndrome. The role of the sympathetic nervous system and psychiatric factors is stressed; the treatment is also discussed.

G. O. STOREY

Pain in the Shoulder and Arm from Neurological Involvement. P. C. BUCY and H. R. OBERHILL. *J. Amer. med. Ass.*, 1959, **169**, 798.

The case histories of patients with pain in the arm and shoulder due to involvement of the peripheral nerves are given. The main causes are discussed.

G. O. STOREY

Pain in the Shoulder and Upper Extremity. E. H. MORGAN. *J. Amer. med. Ass.*, 1959, **169**, 804.

The main causes of pain in the shoulder and upper extremities are given. These are divided into local and remote. The differential diagnosis is discussed.

G. O. STOREY

Shoulder Pain. J. T. NICHOLSON and H. S. WIEDER. *J. Amer. med. Ass.*, 1959, **169**, 809.

In this paper the authors discuss mainly the local causes of pain in the shoulder. The lesions are divided into acute and chronic, and the treatment is discussed.

G. O. STOREY

Physical Treatment of the Painful Arm and Shoulder. P. A. NELSON. *J. Amer. med. Ass.*, 1959, **169**, 814.

Accurate diagnosis in cases of painful arm and shoulder is considered to be the first essential. Some forms of physical treatment which may be used are indicated.

G. O. STOREY

Potential for Rehabilitation in Quadriplegic Teenagers. H. KENT. *J. Amer. med. Ass.*, 1959, **169**, 817.

Success in rehabilitation of teenagers with quadriplegia is often greater than with other age groups. The factors which determine success and some of the difficulties are discussed and a good summary of rehabilitation is given.

G. O. STOREY

Multiple Ossification Centres in the Epiphyses of the Long Bones of the Human Hand and Foot. A. F. ROCHE and S. SUNDERLAND. *J. Bone Jt Surg.*, 1959, **41B**, 375.

This paper from the University of Melbourne draws attention to the frequent occurrence of multiple ossification centres in many epiphyses of the hand and foot. A representative group of 60 boys and 60 girls

were examined at three-monthly intervals from the age of 2 to 4 years. The radiographic technique was carefully standardized. The radiological findings in relation to the epiphysial centres of ossification of each metacarpal, metatarsal, and phalanx were recorded and classified.

There was a high incidence of multiple centres of ossification in the epiphyses occurring in apparent patterns. It is suggested that the clinical importance of understanding these patterns lies in avoiding confusion and error in the diagnosis of such diseases as osteochondritis and epiphysitis.

P. J. R. NICHOLS

Blood Flow Through the Human Forearm following Different Types, Intensities, and Durations of Exercise. A. C. BAUER and C. J. IMIG. *Amer. J. phys. Med.*, 1959, **38**, 48.

This paper describes methods of measuring the maximum level of blood-flow increase during different types of exercise of the muscles of the forearm. Such methods provide a useful means of evaluating the peripheral vascular response to exercise.

J. R. BURROWS

Bone Peg Arthrodesis of First Metatarsophalangeal Joint. G. S. TUPMAN. *Post-Grad. med. J.*, 1959, **33**, 583.

This is a review of 33 cases in which arthrodesis of the metatarsophalangeal joint was performed, using a beef-bone peg as a graft. The indications for this operation include rheumatoid arthritis, hallux valgus, poliomyelitis, failed Keller's operation, and hallux rigidus. The procedure is not offered as a substitute for Keller's operation, but as an alternative where there is likely to be increased forefoot pain by the production of a pseudarthrodesis. It is emphasized that the interphalangeal joint of the hallux must be mobile. The operative technique is described, and the period of immobilization is given as ten weeks. In 30 of the 33 cases the arthrodesis was found to be sound clinically and radiologically.

E. N. COOMES

Prognosis in Osteitis Ilii Condensans. J. K. ISLEY and G. J. BAGLIN. *Radiology*, 1959, **72**, 234.

A series of cases of osteitis condensans ilii is presented in which the diagnosis was made on the basis of radiological findings alone. On follow-up examination a high percentage of the cases showed varying degrees of clinical and radiological improvement. The authors believe that the condition is a benign, self-limiting disease which undergoes spontaneous regression.

G. O. STOREY

Evaluation of the Psychological Effects of Occupational Therapy. F. C. SHONTZ. *Amer. J. phys. Med.*, 1959, **38**, 138.

The first part of this paper is a discussion of the methods of "addition" and "subtraction" in the evaluation of a given method of treatment. The second part is a demonstration study of the psychological effects of "diversional" occupational therapy on 10 chronically sick in-patients by evaluation of alterations of A.D.L. (activities of daily living) and social adjustment in the ward. The author concludes that these changes are measurable and worthy of further study.

J. R. BURROWS

We regret to announce the death of Sir FRANK FOX, O.B.E., who was elected the first honorary member of the British Association of Physical Medicine in 1946.

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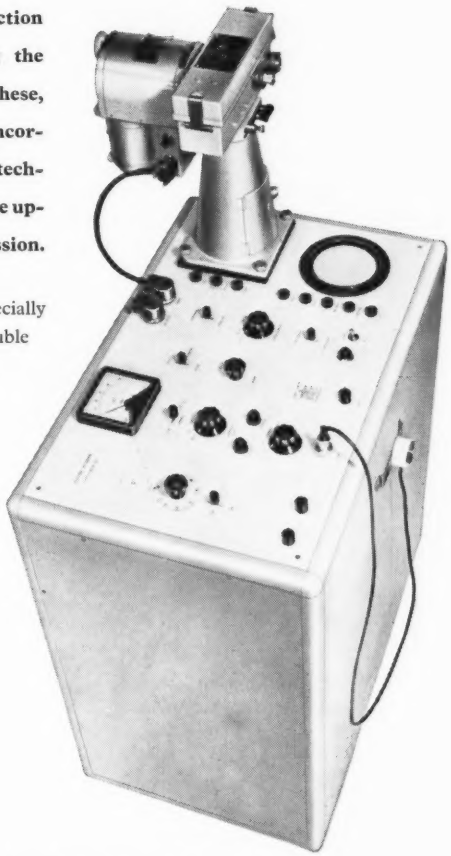

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